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1220 WASHINGTON AVE., STATE CAMPUS, ALBANY, NEW YORK 12232

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TECHNICAL REPORT 85-3

ASPHALT CEMENT MONITOR PROGRAM
FALL 1984

materials bureau technical services division

MARCH 1985

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TECHNICAL REPORT 85-3

ASPHALT CEMENT MONITOR PROGRAM
FALL 1984

Prepared by

Ronald L. Zack
Senior Engineering Materials Chemist

Steven J. Palko
Senior Engineering Materials Technician

February 1985

MATERIALS BUREAU
JAMES J. MURPHY, DIRECTOR

NEW YORK STATE DEPARTMENT OF TRANSPORTATION
1220 WASHINGTON AVENUE, ALBANY, NY 12232

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Preface

Each year the Materials Bureau conducts a monitor testing program in cooperation with various suppliers of asphalt cement. Samples are obtained by Bureau personnel and split for testing by both the supplier and the Bureau in accordance with standard AASHTO test procedures. This report summarizes the results of the 1984 program.

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I. Introduction

During September and October, 1984, personnel from the Materials Bureau Chemistry Laboratory Section obtained twenty samples from thirteen suppliers of asphalt cement. These samples represented many of the sources which had supplied material to the Department during the 1984 construction season including Boscan, Maya, Mid Continent, Canadian, Arab, Venezuelan and other various crude sources.

At the time of sampling, the twenty samples were split into two parts. One part was given to the asphalt supplier while the other was returned to the Bureau's Laboratory. All tests were conducted in accordance with the applicable AASHTO test procedures.

Two standard test report forms and one sample identification form were provided by the Bureau for recording sample information and all test results. Each supplier submitted the test results to the Bureau for review and incorporation into this report.

II. Sample Information

A. The distribution of the samples by grade was as follows:

Grade	Number of Samples
Flux	4
AC-5	2
AC-15	3
AC-20	8
85/100	3

B. The supplier, location, crude source and lot number are tabulated below.

Flux

Supplier	Location	Lot	Crude Source
Chevron	Perth Amboy, NJ	20	Boscan - Maya
Cibro	Albany, NY	41	Boscan
Marathon	Tonawanda	7	Mid Continent and Candian
United Refinery	Warren, PA	12	Western Canadian

AC-5

Supplier	Location	Lot	Crude Source
Petro Canada	Montreal, Quebec	1	Mexican Menemota
Petro Canada	Oakville, Ontario	317/318	Bow River

AC-15

Supplier	Location	Lot	Crude Source
Marathon	Tonawanda	12	Mid Continent and Canadian
Petro Canada	Oakville, Ontario	315/316	Bow River
United Refinery	Warren, PA	11	Western Canadian

AC-20

Supplier	Location	Lot	Crude Source
Arco	Philadelphia, PA	31	Maya Crude and North Slope
Chevron	Perth Amboy, NJ	19	Boscan and Maya
Cibro	Albany, NY	42	Boscan
Exxon	Linden, NJ	14	North Slope - Maya - Arab Heavy
Marathon	Tonawanda	9	Mid Continent and Candian
Monaco	Pittsford, NY	20	Boscan
Parco	Stamford, CT	36	Boscan - Maya
West Bank Oil	Perth Amboy, NJ	11	Corpovan and Baja Grande, Venezuela

85/100

Supplier	Location	Lot	Crude Source
Gulf Canada	Montreal, Quebec	38/40	Lloydminster Canadian
Petro Canada	Montreal, Quebec	1	Mexican Menemota and Western Condensate
Shell Canada	Montreal, Quebec	1	Canadian, Venezuelan, Mexican

III. Test Performed

A. Tests required by Department of Transportation Specification: (all tests not required on all items of asphalt cement)

1. Viscosity @ 140°F, Absolute, (AASHTO T202)
2. Viscocity @ 275°F, Kinematic, (AASHTO T201)
3. Penetration @ 77°F, (AASHTO T49)
4. Ductility @ 39.2°F, (AASHTO T51)
5. Flash Point, Cleveland Open Cup, (AASHTO T48)
6. Solubility in Trichloroethylene, (AASHTO T44)
7. % Loss on Thin Film Oven Test Residue, (AASHTO T179)
8. Penetration @ 77°F on Thin Film Oven Test Residue (AASHTO T49)
9. Penetration @ 77°F Ratio (% of Original) between the Thin Film Oven Test Residue and the Penetration @ 77°F on the orginal sample
10. Viscosity @ 140°, Absolute on Thin Film Oven Test Residue (AASHTO T202)
11. Ductility @ 77°F on Thin Film Oven Test Residue (AASHTO T51)

B. Additional tests not required by Department of Transportation Specifications:

1. Penetration @ 39.2°F (AASHTO T49)
2. Penetration Ratio: 39.2°F/77°F
3. Ductility @ 77°F (AASHTO T51)
4. Specific Gravity @ 77°F (AASHTO T228)
5. Softening Point, Ethylene Glycol (AASHTO T53)
6. Viscosity @ 275°F, Kinematic, on Thin Film Oven Test Residue (AASHTO T201)
7. Ductility @ 60°F on Thin Film Oven Test Residue (AASHTO T51)
8. Viscosity @ 140°F, Absolute, Ratio, between viscosity @ 140°F, Absolute on Thin Film Oven Test Residue Sample and the original sample.
9. A Settling Test to Evaluate the Relative Degree of Dispersion of Asphaltenes.
10. Chemical Analysis of asphalt cement.

C. A Penetration Viscosity Number (PVN) and a Pentration Index Number (PIN) has been computed for each asphalt cement sample.

IV. Test Data and Sample Identification Forms

On the following pages are the Standard Test Report and Sample Identification Forms used for this project.

PRIMARY SOURCE	LOCATION
CRUDE SOURCE	SAMPLED AT
SAMPLED BY	DATE SAMPLED
ITEM NO.	GRADE TYPE
LOT NO,	DATE OF CERTIFICATION

REAMRKS:

NEW YORK STATE

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		TEST NO.
PRIMARY SOURCE		LOCATION
LOT NO.	ITEM NO.	GRADE TYPE
CRUDE SOURCE		

	AASHTO	RESULTS
1. Viscosity Ratio @ 140 F		
a.) Viscosity of Original Sample,(poises)	T 202	
b.) Viscosity After T.F.O.T.,(poises)	T 202	
2. Viscosity @ 275 F, Centistokes	T 201	
3. Penetration @ 77 F, 100g., 5 sec.	T 49	
4. Penetration @ 39.2 F, 200g., 60 sec.	T 49	
5. Penetration Ratio (39.2°F/77°F) 100		
6. Ductility @ 39.2 F, 1 cm/min., cm.	T 51	
7. Ductility @ 77 F, 5cm/min., cm.	T 51	
8. Flash Point C.O.C., F	T 48	
9. Solubility in Trichloroethylene	T 44	
10. Loss on Heating T.F.O.T.,Percent, 325F @ 5 Hrs	T 179	
11. Specific Gravity @ 77 F	T 228	
12. Ductility @ 60 F, T.F.O.T., 5cm/min., cm.	T 51	
13. Ductility @ 77 F, T.F.O.T., 5cm/min., cm.	T 51	
14. Penetration @ 77 F, T.F.O.T., 100g., 5 sec.	T 49	
a.) Percent of Original		
15. Viscosity @275 F After T.F.O.T. (cst)	T 201	
16. Penetration Viscosity Number, PVN		
17. Softening Point, Ethylene Glycol,°F	T 53	
18. Penetration Index Number, PIN		

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	TEST NO.
PRIMARY SOURCE	LOCATION
LOT NO.	ITEM NO. / GRADE TYPE
CRUDE SOURCE	

ASPHALT COMPOSITION ANALYSIS

ASPHALTENES, %	
SATURATES, %	
NAPHTHENE AROMATICS, %	
POLAR AROMATICS, %	

A Settling Test to Evaluate the Relative Degree of Dispersion of Asphaltenes

SETTLEMENT TIME, MINUTES	

V. NEW YORK STATE DEPARTMENT OF TRANSPORTATION SPECIFICATIONS FOR ASPHALT CEMENT

TABLE 702-1

ASPHALT CEMENTS FOR PAVING

MATERIAL DESIGNATION	702-0100		702-0200		702-0300		702-0400		702-0500	
VISCOSITY GRADE	AC-2.5		AC -5		AC-10		AC-15		AC-20	
Test Requirements	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Viscosity 140F (60 C), P	200	300	400	600	800	1200	1200	1800	1600	2400
Viscosity 275F(135 C), cSt	125		175		250		275		300	
Penetration 77F (25C),100g, 5s	200	325	120	200	70	120	60	100	60	100
Flash Point COC, F(C)	325(163)		350(177)		425(219)		435(225)		450(232)	
Solubility in Trichloroethylene,%	99.0		99.0		99.0		99.0		99.0	
Tests on Residue from Thin Film Oven Test										
Viscosity, 140 F(60C), P		1250		2500		5000		7500		10,000
Ductility, 77 F(25C) 5 cm/min., cm	100		100		75		60		50	
TYPICAL USES (intended only as a general information guide)	Recycle Mix		Hot plant mix very cold climate. Recycle Mix.		Hot plant mix cold climate. Recycle Mix.		Hot plant mix moderate climate.		Hot plant mix moderate climate. Sheet mixes. Open graded surface course mixes.	

TABLE 702-2

MISCELLANEOUS ASPHALT CEMENTS

MATERIAL DESIGNATION	702-0600	
GRADE	85-100	
TEST REQUIREMENTS	Min	Max
Penetration,77F(25C), 100g, 5s	85	100
Viscosity,275F(135C), cSt	280	
Flash Point, COC, F	450	
Solubility in trichloroethylene,%	99.5	
Ductility, 39.2F(4C), 1cm/min., cm	6	
Tests on residue from Thin-film Oven Test (AASHTO T179)		
Loss on Heating, 325F, 5h, %		.85
Penetration, % original	47	
Ductility, 77F(25C), 5cm/min., cm	75	
Typical Uses	Hot plant mix moderate climate	

SPECIFICATION
CHEVRON
ASPHALT FLUX FOR RECYCLING

TEST REQUIREMENTS	MIN	MAX
Viscosity, 140F(60C), Poises	600	800
Viscosity, 275F(135C), cst	200	-
Penetration, 77F(25C), 100g., 5 sec.	140	190
Flash Point, C.O.C., F	350	-
Solubility in Trichloroethylene, %	99.0	-
Tests on Residue from Thin Film Oven Test:		
Viscosity, 140F(60C), Poises	-	3200
Ductility, 77F(25C), 5cm/min., cm.	100	-

SPECIFICATION
CIBRO
ASPHALT FLUX FOR RECYCLING

TEST REQUIREMENTS	MIN	MAX
Viscosity, 140F(60C), Poises	800	1200
Viscosity, 275F(135C), cst	175	-
Penetration, 77F(25C), 100g., 5 sec.	125	175
Flash Point, C.O.C., F	400	-
Solubility in Trichloroethylene, %	99.0	-
Tests on Residue from Thin Film Oven Test:		
Viscosity, 140F(60C), Poises	-	4000
Ductility, 77F(25C), 5cm/min., cm.	75	-

SPECIFICATION
MARATHON
ASPHALT FLUX FOR RECYCLING

TEST REQUIREMENTS	MIN	MAX
Viscosity, 140F(60C), Poises	400	600
Viscosity, 275F(135C), cst	175	-
Penetration, 77F(25C), 100g., 5 sec.	175	225
Flash Point, C.O.C., F	350	-
Solubility in Trichloroethylene, %	99.0	-
Tests on Residue from Thin Film Oven Test:		
Viscosity, 140F(60C), Poises	-	2500
Ductility, 77F(25C), 5cm/min., cm.	100	-

SPECIFICATION
UNITED REFINING
ASPHALT FLUX FOR RECYCLING

TEST REQUIREMENTS	MIN	MAX
Viscosity, 140F(60C), Poises	300	500
Viscosity, 275F(135C), cst	125	-
Penetration, 77F(25C), 100g., 5 sec.	150	200
Flash Point, C.O.C., F	350	-
Solubility in Trichloroethylene, %	99.0	-
Tests on Residue from Thin Film Oven Test:		
Viscosity, 140F(60C), Poises	-	2500
Ductility, 77F(25C), 5cm/min., cm.	100	-

VI. Summary of Test Results

Test results for all twenty asphalt cement samples met New York State Deparment of Transporation Specification requirements. The following exceptions are noted below:

A. United Refinery, Warren , PA.

FLUX	Lot 12	Western Candian Crude
Solubility in Trichloroethylene		98.9%
Specification Requirement		99.0% minimum

VII. Test Results

On the following pages is a tabulation of all test results. The column headed by the name of the test contains the test result determined by the Materials Bureau. The column headed by "Comparative Results" contains the test result provided by the supplier for the test indicated in the column immediatley to the left.

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VII. Test Results

On the following pages is a tabulation of all test results. The column headed by the name of the test contains the test result determined by the Materials Bureau. The column headed by "Comparative Results" contains the test result provided by the supplier for the test indicated in the column immediatley to the left.

1984 ASPHALT CEMENT MONITOR PROGRAM

AC	Supplier - Location - Lot	Crude Source	Absolute Viscosity @140°F	Comparative Results	Kinematic Viscosity @275°F	Comparative Results	Penetration @ 77°F	Comparative Results	Penetration @39.2°F	Comparative Results	Penetration Ratio 39.2°/77°F	Comparative Results
FLUX	Chevron, Perth Amboy 20	Boscan-Maya	762	745	289	283	166	165	60	*	36.1	*
FLUX	Cibro, Albany 41	Boscan	995	1018	343	312	154	160	59	60	38.3	37.5
FLUX	Marathon, Tonawanda 7	Mid. Cont.-Canadian	491	495	212	208	184	190	61	59	33.2	31.1
FLUX	United Ref., Warren 12	W. Canadian	343	330	153	149	161	160	37	32	23.0	20.0
	$\bar{X}$		648	647	249	238	166	169	54	50	32.7	29.5
	σ		289.3	300.5	83.7	73.8	12.8	14.4	11.5	15.9	6.8	8.9
5	Petro. Can., Montreal 1	Mexican Menemota	503	508	208	199	171	171	55	58	32.2	33.9
5	Petro Can., Oakville 317/318	Bow River	518	518	219	214	173	174	50	*	28.9	*
	$\bar{X}$		511	513	214	207	172	173	53		30.6	
	σ		10.6	7.1	7.8	10.6	1.4	2.1	3.5		2.3	
15	Marathon, Tonawanda 12	Mid. Cont.-Canadian	1341	1404	334	331	86	90	26	27	30.2	30.0
15	Petro Can., Oakville 315/316	Bow River	1401	1354	345	345	84	87	26	*	31.0	*
15	United Ref., Warren 11	W. Canadian	1523	1496	356	349	65	69	19	15	29.2	21.7
	$\bar{X}$		1422	1418	345	342	78	82	24	21	30.1	25.9
	σ		92.7	72.0	11.0	9.5	11.6	11.4	4.0	8.5	0.9	5.9
20	Arco, Philadelphia 31	Maya/No. Slope	2073	2047	425	423	71	74	26	28	36.6	37.8
20	Chevron, Perth Amboy 19	Boscan-Maya	2090	2093	463	455	82	83	32	*	39.0	*
20	Cibro, Albany 42	Boscan	2158	2242	497	481	91	94	35	32	38.5	34.0
20	Exxon, Linden 14	Maya-Arab Hvy. No. Slope	1927	2180	407	406	70	70	24	*	34.3	*
20	Marathon, Tonawanda 9	Mid-Cont.-Canadian	1866	1902	381	391	72	74	24	25	33.3	33.8
20	Monoco, Pittsford 20	Boscan	2022	2078	435	405	76	81	26	28	34.2	34.6
20	Parco, Stamford 36	Boscan-Maya	2079	1811	461	*	83	82	32	*	38.6	*
20	West Bank, P. Amboy 11	Corpovn-Venezuela	2270	2179	495	471	83	85	30	*	36.1	*
	$\bar{X}$		2061	2067	446	433	79	80	29	28	36.3	35.1
	σ		126.4	146.3	41.1	35.6	7.4	7.6	4.2	2.9	2.2	1.9
85/100	Gulf Can., Montreal 38/40	Lloydminster Canadian	1137	1234	306	314	88	88	28	24	31.8	27.3
85/100	Petro Can., Montreal 1	Mex. Menemota W. Condensate	1269	1263	319	312	89	94	32	28	36.0	29.8
85/100	Shell Can., Montreal 1	Can. - Mex.-Venz.	1662	*	403	374	85	92	30	*	35.3	*
	$\bar{X}$		1356	1249	343	333	87	91	30	26	34.4	28.6
	σ		273.1	20.5	52.7	35.2	2.1	3.1	2.0	2.8	2.3	1.8

*Results Not Given

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AC	Supplier - Location - Lot	Crude Source	T.F.O.T. Loss %	Comparative Results	T.F.O.T. Ductility @ 60°F	Comparative Results	T.F.O.T. Ductility @ 77°F	Comparative Results	T.F.O.T. Viscosity @ 140°F	Comparative Results	T.F.O.T. Viscosity Ratio	Comparative Results
FLUX	Chevron, Perth Amboy 20	Boscan - Maya	0.776	*	75.75	*	150.0+	110.0+	3103	2878	4.07	3.86
FLUX	Cibro, Albany 41	Boscan	1.393	1.100	136.50	150.0+	150.0+	150.0+	3630	3551	3.65	3.49
FLUX	Marathon, Tonawanda 7	Mid. Cont. - Canadian	0.287	0.370	150.0+	150.0+	150.0+	150.0+	1170	1211	2.38	2.45
FLUX	United Ref., Warren 12	W. Canadian	+0.130 gain	+0.030 gain	150.0+	120.0	126.25	130.0+	693	612	2.02	1.85
	$\bar{X}$		0.614	0.490	128.1	140.0	144.1		2149	2063	3.03	2.91
	σ		0.610	0.560	35.5	17.3	11.9		1435.5	1379.6	0.98	0.93
5	Petro Can., Montreal 1	Mexican Menemota	0.147	0.250	150.0+	126.0	150.0+	140.0	1267	1675	2.52	3.30
5	Petro Can., Oakville 317/318	Bow River	+0.071 gain	+0.050 gain	150.0+	*	150.0+	121.0	1044	960	2.02	1.85
	$\bar{X}$		0.074	0.125	150.0+		150.0+	130.5	1156	1318	2.27	2.58
	σ		0.104	0.177	—		—	13.4	157.7	505.6	0.35	1.03
15	Marathon, Tonawanda 12	Mid-Cont. Canadian	0.133	0.170	105.75	150.0+	150.0+	150.0+	3356	3351	2.50	2.39
15	Petro Can., Oakville 315/316	Bow River	+0.054 gain	0.040	139.0	*	150.0+	150.0+	3186	2910	2.27	2.15
15	United Ref., Warren 11	W. Canadian	0.315	+0.020 gain	14.25	14.0	150.0+	130.0+	3999	3482	2.63	2.33
	$\bar{X}$		0.149	0.070	86.3	82.0	150.0+		3514	3248	2.47	2.29
	σ		0.158	0.089	64.6	96.2	—		428.8	299.7	0.18	0.12
20	Arco, Philadelphia 31	Maya - No. Slope	0.032	0.034	23.0	40.0	150.0+	*	6355	5541	3.07	2.71
20	Chevron, Perth Amboy 19	Boscan - Maya	0.290	0.410	30.0	*	137.75	100.0+	7524	7366	3.60	3.52
20	Cibro, Albany 42	Boscan	0.860	0.670	108.50	38.50	150.0+	150.0+	7607	7490	3.53	3.34
20	Exxon, Linden 14	Maya - Arab Hvy. No. Slope	+0.013 gain	0.138	42.0	49.0	150.0+	150.0+	4934	3856	2.56	1.77
20	Marathon, Tonawanda 9	Mid-Cont. - Canadian	0.103	0.140	91.50	79.0	150.0+	150.0+	4584	4436	2.46	2.33
20	Monoco, Pittsford 20	Boscan	0.312	0.270	51.25	35.0	150.0+	122.0+	5443	5951	2.69	2.86
20	Parco, Stamford 36	Boscan - Maya	0.268	*	25.75	*	138.0	*	7243	*	3.48	*
20	West Bank, P. Amboy 11	Corpovan - Venezuela	0.343	0.249	74.75	31.0	150.0+	*	6623	5527	2.92	2.54
	$\bar{X}$		0.276	0.273	55.8	45.4	147.0		6289	5738	3.04	2.72
	σ		0.271	0.212	32.2	17.5	5.6		1180.0	1359.3	0.46	0.60
85/100	Gulf Can., Montreal 38/40	Lloydminster Canadian	0.024	0.010	120.75	150.0+	150.0+	150.0+	2883	2292	2.54	1.86
85/100	Petro Can., Montreal 1	Mex. Menemota W. Condensate	0.075	0.020	47.0	50.0	150.0+	140.0	3585	3295	2.83	2.61
85/100	Shell Can., Montreal 1	Can. - Mex. - Venz.	+0.091 gain	+0.100 gain	31.75	*	150.0+	125.0+	4166	*	2.51	*
	$\bar{X}$		0.033	0.010	66.5	100.0	150.0+		3545	2794	2.63	2.24
	σ		0.038	0.010	47.6	70.7	—		642.5	709.2	0.18	0.53

* Results Not Given

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AC	Supplier - Location - Lot	Crude Source	T.F.O.T. Viscosity @ 275°F	Comparative Results	T.F.O.T. Penetration @ 77°F	Comparative Results	T.F.O.T. Penetration Ratio	Comparative Results	Specific Gravity @ 77°F	Comparative Results	C.O.C. Flash Point, °F	Comparative Results
FLUX	Chevron, Perth Amboy 20	Boscan - Maya	524	517	78	78	47.0	47.3	1.026	1.024	480	495
FLUX	Cibro, Albany 41	Boscan	668	628	71	81	46.1	50.6	1.028	1.026	470	450
FLUX	Marathon, Tonawanda 7	Mid Cont. - Canadian	303	294	100	103	54.3	54.2	1.018	1.019	545	595
FLUX	United Ref., Warren 12	W. Canadian	195	184	95	100	59.0	62.5	1.004	0.999	635	630
	$\bar{X}$		423	406	86	91	51.6	53.7	1.019	1.017	533	543
	σ		213.4	202.8	13.7	12.8	6.1	6.5	0.011	0.012	76.0	84.1
5	Petro Can., Montreal 1	Mexican Menemota	299	344	94	85	55.0	49.7	1.017	1.016	545	545
5	Petro Can., Oakville 317/318	Bow River	290	*	104	105	60.1	60.3	1.015	1.015	595	597
	$\bar{X}$		295		99	95	57.6	55.0	1.016	1.016	570	571
	σ		6.4		7.1	14.1	3.6	7.5	0.001	0.001	35.4	36.8
15	Marathon, Tonawanda 12	Mid Cont. - Canadian	478	487	52	53	60.5	58.9	1.025	1.026	590	610
15	Petro Can., Oakville 315/316	Bow River	477	*	52	56	61.9	64.4	1.023	1.023	600	615
15	United Ref., Warren 11	W. Canadian	501	465	39	43	60.0	62.3	1.004	1.006	620	630
	$\bar{X}$		485	476	48	51	60.8	61.9	1.017	1.018	603	618
	σ		13.6	15.6	7.5	6.8	1.0	2.8	0.012	0.011	15.3	10.4
20	Arco, Philadelphia 31	Maya - No. Slope	637	*	45	48	63.4	64.9	1.029	1.026	625	580
20	Chevron, Perth Amboy 19	Boscan - Maya	805	805	49	48	59.8	57.8	1.032	1.031	520	515
20	Cibro, Albany 42	Boscan	892	845	49	53	53.8	56.4	1.032	1.036	470	495
20	Exxon, Linden 14	Maya-Arab Hvy. No. Slope	597	551	46	47	65.7	67.1	1.027	1.034	605	550+
20	Marathon, Tonawanda 9	Mid Cont. - Canadian	564	543	45	47	62.5	63.5	1.028	1.028	565	600+
20	Monoco, Pittsford 20	Boscan	666	686	47	44	61.8	54.3	1.029	1.033	570	595
20	Parco, Stamford 36	Boscan - Maya	792	*	49	*	59.0	*	1.032	*	520	*
20	West Bank, P. Amboy 11	Corpovan - Venezuela	808	*	51	51	61.4	60.0	1.033	1.032	505	510
	$\bar{X}$		720	686	48	48	60.9	60.6	1.030	1.031	548	
	σ		118.9	139.7	2.2	2.9	3.5	4.7	0.002	0.003	52.7	
85/100	Gulf Can., Montreal 38/40	Lloyd Minster Canadian	448	400	53	60	60.2	68.2	1.027	1.027	560	545
85/100	Petro Can., Montreal 1	Mex. Menemota W. Condensate	470	454	54	56	60.7	59.6	1.022	1.022	555	560
85/100	Shell Can., Montreal 1	Can. - Mex. - Venz.	579	*	56	61	65.9	66.3	1.017	1.017	630	310+
	$\bar{X}$		499	427	54	59	62.3	64.7	1.022	1.022	582	
	σ		70.1	38.2	1.5	2.6	3.2	4.5	0.005	0.005	41.9	

*Results Not Given

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1984 ASPHALT CEMENT MONITOR PROGRAM

AC	SUPPLIER - LOCATION - LOT	CRUDE SOURCE	DUCTILITY @39.2°F	COMPARATIVE RESULTS	DUCTILITY @77°F	COMPARATIVE RESULTS	SOLUBILITY %	COMPARATIVE RESULTS	SOFTENING PNT. °F	COMPARATIVE RESULTS	PVN	COMPARATIVE RESULTS
FLUX	CHEVRON, PERTH AMBOY 20	BOSCAN - MAYA	150.0+	*	97.0	*	99.97	99.98	109	*	-0.111	-0.154
FLUX	CIBRO, ALBANY 41	BOSCAN	150.0+	*	114.25	150.0+	99.99	99.98	110	104	+0.078	-0.030
FLUX	MARATHON, TONAWANDA 7	MID CONT. - CANADIAN	150.0+	15.0+	92.50	150.0+	99.97	99.92	107	114	-0.510	-0.502
FLUX	UNITED REF., WARREN 12	W. CANADIAN	150.0+	*	89.25	130.0+	98.93	*	113	115	-1.227	-1.279
	$\bar{X}$		150.0+		98.25		99.72	99.96	110	111	-0.443	-0.491
	σ		—		11.1		0.52	0.03	2.5	6.1	0.578	0.562
5	PETRO CAN., MONTREAL 1	MEXICAN MENEMOTA	150.0+	75.0+	95.0	140.0+	99.97	99.96	105	106	-0.634	-0.710
5	PETRO CAN., OAKVILLE 317/318	BOW RIVER	150.0+	15.0+	125.25	*	99.98	99.89	107	*	-0.532	-0.564
	$\bar{X}$		150.0+		110.1		99.98	99.93	106		-0.583	-0.637
	σ		—		21.4		0.01	0.05	1.4		0.072	0.103
15	MARATHON, TONAWANDA 12	MID CONT. CANADIAN	39.75	15.0+	150.0+	150.0+	99.98	99.98	115	121	-0.664	-0.629
15	PETRO CAN., OAKVILLE 315/316	BOW RIVER	38.75	15.0+	150.0+	*	99.98	99.90	118	*	-0.641	-0.603
15	UNITED REF., WARREN 11	W. CANADIAN	6.25	*	150.0+	130.0+	99.28	*	121	123	-0.858	-0.827
	$\bar{X}$		28.25		150.0+		99.75	99.94	118	122	-0.721	-0.686
	σ		19.1		—		0.40	0.06	3.0	1.4	0.119	0.123
20	ARCO, PHILADELPHIA 31	MAYA - NO. SLOPE	11.25	*	150.0+	*	99.97	99.97	122	*	-0.514	-0.477
20	CHEVRON, PERTH AMBOY 19	BOSCAN - MAYA	26.25	*	150.0+	*	99.97	99.70	120	*	-0.231	-0.243
20	CIBRO, ALBANY 42	BOSCAN	140.75	*	138.0	150.0+	99.99	99.99	121	125	-0.003	-0.013
20	EXXON, LINDEN 14	MAYA-ARAB HV. NO. SLOPE	14.50	*	150.0+	*	99.99	99.99	125	*	-0.591	-0.595
20	MARATHON, TONAWANDA 9	MID CONT. - CANADIAN	18.25	9.0	150.0+	150.0+	99.99	99.98	124	122	-0.658	-0.591
20	MONOCO, PITTSFORD 20	BOSCAN	25.75	*	150.0+	150.0+	99.99	99.96	122	*	-0.407	-0.443
20	PARCO, STAMFORD 36	BOSCAN - MAYA	21.25	*	150.0+	*	99.97	*	121	*	-0.223	*
20	WEST BANK, P. AMBOY 11	CORPOVAN - VENEZUELA	82.50	*	150.0+	*	99.99	99.90	121	*	-0.118	-0.164
	$\bar{X}$		42.6		148.5	150.0+	99.98	99.93	122	124	-0.343	-0.361
	σ		45.7		4.2	—	0.01	0.10	1.7	2.1	0.235	0.224
85/100	GULF CAN., MONTREAL 38/40	LLOYDMINSTER CANADIAN	73.75	40.0	150.0+	150.0+	99.91	99.70	117	118	-0.771	-0.732
85/100	PETRO CAN., MONTREAL 1	MEX. MENEMOTA W. CONDENSATE	38.0	26.0	150.0+	140.0+	99.96	99.95	119	116	-0.697	-0.671
85/100	SHELL CAN., MONTREAL 1	CAN. - MEX. VENZ.	15.0	4.0	150.0+	150.0+	99.96	99.70	118	*	-0.397	-0.420
	$\bar{X}$		42.25	23.3	150.0+		99.94	99.78	118	117	-0.622	-0.608
	σ		29.6	18.1	—		0.03	0.14	1.0	1.4	0.198	0.165

*RESULTS NOT GIVEN

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1984 ASPHALT CEMENT MONITOR PROGRAM

AC	Supplier - Location - Lot	Crude Source	PIN	Comparative Results	Settlement Test Minutes	Asphaltenes %	Saturates %	% Naphthene Aromatics	% Polar Aromatics
FLUX	Chevron, Perth Amboy 20	Boscan - Maya	+0.271	*	19.5	17.5	9.7	24.5	39.4
FLUX	Cibro, Albany 41	Boscan	+0.164	-0.991	18.5	18.0	12.3	25.6	41.9
FLUX	Marathon, Tonawanda 7	Mid Cont. - Canadian	+0.292	+1.911	33.7	10.7	13.0	29.1	43.4
FLUX	United Ref., Warren 12	W. Canadian	+0.946	+1.297	46.6	7.6	13.4	34.7	37.3
	$\bar{X}$		+0.418	0.739	29.6	13.5	12.1	28.5	40.5
	σ		0.356	1.529	13.3	5.1	1.7	4.6	2.7
5	Petro Can., Montreal 1	Mexican Menemota	-0.488	-0.258	42.8	13.8	13.6	28.8	36.6
5	Petro Can., Oakville 317/318	Bow River	+0.016	*	31.1	11.6	19.4	22.8	42.0
	$\bar{X}$		-0.236		37.0	12.7	16.5	25.8	39.3
	σ		0.356		8.3	1.6	4.1	4.2	3.8
15	Marathon, Tonawanda 12	Mid Cont. - Canadian	-0.893	+0.201	36.3	10.7	10.2	27.1	43.9
15	Petro Can., Oakville 315/316	Bow River	-0.472	*	25.8	12.2	9.6	28.8	42.7
15	United Ref., Warren 11	W. Canadian	-0.712	-0.267	63.7	6.9	10.3	37.0	39.1
	$\bar{X}$		-0.692	-0.033	41.9	9.9	10.0	31.0	41.9
	σ		0.211	0.331	19.6	2.7	0.4	5.3	2.5
20	Arco, Philadelphia 31	Maya - No. Slope	-0.334	*	34.5	16.9	11.9	26.2	39.1
20	Chevron, Perth Amboy 19	Boscan - Maya	-0.230	*	20.6	19.2	8.8	25.1	39.9
20	Cibro, Albany 42	Boscan	+0.235	+0.934	17.3	17.9	5.5	24.0	43.1
20	Exxon, Linden 14	Maya - Arab Hvy. No. Slope	+0.055	*	30.8	14.6	9.3	29.5	41.5
20	Marathon, Tonawanda 9	Mid Cont. - Canadian	-0.008	-0.221	33.0	12.9	16.6	20.1	44.4
20	Monoco, Pittsford 20	Boscan	-0.146	*	23.9	15.6	8.2	26.2	43.9
20	Parco, Stamford 36	Boscan - Maya	-0.042	*	18.9	18.9	8.6	24.2	40.6
20	West Bank, P. Amboy 11	Corpovan - Venezuela	-0.042	*	18.2	17.5	6.2	24.1	44.3
	$\bar{X}$		-0.064	+0.357	24.7	16.7	9.4	24.9	42.1
	σ		0.175	0.817	7.1	2.2	3.5	2.7	2.1
85/100	Gulf Can., Montreal 38/40	Lloydminster Canadian	-0.497	-0.336	21.3	14.0	12.1	28.1	41.6
85/100	Petro Can., Montreal 1	Mex. Menemota W. Condensate	-0.143	-0.464	44.7	15.4	12.2	28.7	37.6
85/100	Shell Can., Montreal 1	Can. - Mex. Venz.	-0.438	*	130.0	13.3	9.7	33.3	38.5
	$\bar{X}$		-0.359	-0.400	65.3	14.2	11.3	30.0	39.2
	σ		0.190	0.091	57.2	1.1	1.4	2.8	2.1

* Results Not Given

Only one supplier submitted Asphalt Composition Analysis Results to the Materials Bureau.

Petro-Canada, Montreal, Quebec AC-5 and 85/100

Comparison test results are noted as follows:

Asphalt Composition Analysis

AC-5

	Materials Bureau	Petro Canada
% Asphaltenes,	13.8	15.6
% Saturates,	13.6	17.7
% Naphthene Aromatics,	28.8	24.8
% Polar Aromatics,	36.6	37.6

85/100

	Materials Bureau	Petro Canada
% Asphaltenes,	15.4	20.4
% Saturates,	12.2	13.6
% Naphthene Aromatics,	28.7	23.2
% Polar Aromatics,	37.6	38.4

VIII. Statistical Analysis of Test Results

The mean, range and standard deviation were determined for the number of samples tested in each grade of asphalt cement. For each test, this statistical information has been determined separately for the Materials Bureau results and when applicable, the comparable results submitted by the supplier.

A. ABSOLUTE VISCOSITY @ 140°F (POISES)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	648	511	1422	2061	1356
Range	343 to 995	503 to 518	1341 to 1523	1866 to 2270	1137 to 1662
Standard Deviation	289.3	10.6	92.7	126.4	273.1

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	2
Mean	647	513	1418	2067	1249
Range	330 to 1018	508 to 518	1354 to 1496	1811 to 2242	1234 to 1263
Standard Deviation	300.5	7.1	72.0	146.3	20.5

B. KINEMATIC VISCOSITY @ 275°F (CENTISTOKES)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	249	214	345	446	343
Range	153 to 343	208 to 219	334 to 356	381 to 497	306 to 403
Standard Deviation	83.7	7.8	11.0	41.1	52.7

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	7	3
Mean	238	207	342	433	333
Range	149 to 312	199 to 214	331 to 349	391 to 481	312 to 374
Standard Deviation	73.8	10.6	9.5	35.6	35.2

C. PENETRATION @ 77°F

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	166	172	78	79	87
Range	154 to 184	171 to 173	65 to 86	70 to 91	85 to 89
Standard Deviation	12.8	1.4	11.6	7.4	2.1

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	169	173	82	80	91
Range	160 to 190	171 to 174	69 to 90	70 to 94	88 to 94
Standard Deviation	14.4	2.1	11.4	7.6	3.1

D. PENETRATION @ 39.2°F

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	54	53	24	29	30
Range	37 to 61	50 to 55	19 to 26	24 to 35	28 to 32
Standard Deviation	11.5	3.5	4.0	4.2	2.0

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	1	2	4	2
Mean	50	-	21	28	26
Range	32 to 60	-	15 to 27	25 to 32	24 to 28
Standard Deviation	15.9	-	8.5	2.9	2.8

E. PENETRATION RATIO
(Penetration @ 39.2°F ÷ Penetration @ 77°F x 100)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	32.7	30.6	30.1	36.3	34.4
Range	23.0 to 38.3	28.9 to 32.2	29.2 to 31.0	33.3 to 39.0	31.8 to 36.0
Standard Deviation	6.8	2.3	0.9	2.2	2.3

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	1	2	4	2
Mean	29.5	-	25.9	35.1	28.6
Range	20.0 to 37.5	-	21.7 to 30.0	33.8 to 37.8	27.3 to 29.8
Standard Deviation	8.9	-	5.9	1.9	1.8

F. THIN FILM OVEN TEST, % LOSS
(Samples which showed weight gains were calculated as 0.000% loss)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	0.614	0.074	0.149	0.276	0.033
Range	0.000 to 1.393	0.000 to 0.147	0.000 to 0.315	0.000 to 0.860	0.000 to 0.075
Standard Deviation	0.610	0.104	0.158	0.271	0.038

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	7	3
Mean	0.490	0.125	0.070	0.273	0.010
Range	0.000 to 1.100	0.000 to 0.250	0.000 to 0.170	0.034 to 0.670	0.000 to 0.020
Standard Deviation	0.560	0.177	0.089	0.212	0.010

G. THIN FILM OVEN TEST, DUCTILITY @ 60°F, 5cm/min. (CENTIMETERS)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	128.1	150.0+	86.3	55.8	66.5
Range	75.75 to 150.0+	-	14.25 to 139.0	23.0 to 108.50	31.75 to 120.75
Standard Deviation	35.5	-	64.6	32.2	47.6

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	1	2	6	2
Mean	140.0	-	82.0	45.4	100.0
Range	120.0 to 150.0+	-	14.0 to 150.0+	31.0 to 79.0	50.0 to 150.0+
Standard Deviation	17.3	-	96.2	17.5	70.7

H. THIN FILM OVEN TEST, DUCTILITY @ 77°F, 5 cm/min. (CENTIMETERS)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	144.1	150.0+	150.0+	147.0	150.0+
Range	126.25 to 150.0+	-	-	137.75 to 150.0+	-
Standard Deviation	11.9	-	-	5.6	-

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	5	3
Mean	-	130.5	-	-	-
Range	110.0+ to 150.0+	121.0 to 140.0	130.0+ to 150.0+	100.0+ to 150.0+	125.0+ to 150.0+
Standard Deviation	-	13.4	-	-	-

I. THIN FILM OVEN TEST, ABSOLUTE VISCOSITY @ 140°F, (POISES)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	2149	1156	3514	6289	3545
Range	693 to 3630	1044 to 1267	3186 to 3999	4584 to 7607	2883 to 4166
Standard Deviation	1435.5	157.7	428.8	1180.0	642.5

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	7	2
Mean	2063	1318	3248	5738	2794
Range	612 to 3551	960 to 1675	2910 to 3482	3856 to 7490	2292 to 3295
Standard Deviation	1379.6	505.6	299.7	1359.3	709.2

J. ABSOLUTE VISCOSITY @ 140°F RATIO
(After T.F.O.T. Viscosity @ 140°F ÷ Original Viscosity @ 140°F)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	3.03	2.27	2.47	3.04	2.63
Range	2.02 to 4.07	2.02 to 2.52	2.27 to 2.63	2.46 to 3.60	2.51 to 2.83
Standard Deviation	0.98	0.35	0.18	0.46	0.18

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	7	2
Mean	2.91	2.58	2.29	2.72	2.24
Range	1.85 to 3.86	1.85 to 3.30	2.15 to 2.39	1.77 to 3.52	1.86 to 2.61
Standard Deviation	0.93	1.03	0.12	0.60	0.53

K. THIN FILM OVEN TEST, KINEMATIC VISCOSITY @ 275°F, (CENTISTOKES)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	423	295	485	720	499
Range	195 to 668	290 to 299	477 to 501	564 to 892	448 to 579
Standard Deviation	213.4	6.4	13.6	118.9	70.1

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	1	2	5	2
Mean	406	-	476	686	427
Range	184 to 628	-	465 to 487	543 to 845	400 to 454
Standard Deviation	202.8	-	15.6	139.7	38.2

L. THIN FILM OVEN TEST, PENETRATION @ 77°F

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	86	99	48	48	54
Range	71 to 100	94 to 104	39 to 52	45 to 51	53 to 56
Standard Deviation	13.7	7.1	7.5	2.2	1.5

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	7	3
Mean	91	95	51	48	59
Range	78 to 103	85 to 105	43 to 56	44 to 53	56 to 61
Standard Deviation	12.8	14.1	6.8	2.9	2.6

M. PENETRATION @ 77°F RATIO
(After TFOT Penetration @ 77°F ÷ Original Penetration @ 77°F x 100)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	51.6	57.6	60.8	60.9	62.3
Range	46.1 to 59.0	55.0 to 60.1	60.0 to 61.9	53.8 to 65.7	60.2 to 65.9
Standard Deviation	6.2	3.6	1.0	3.5	3.2

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	7	3
Mean	53.7	55.0	61.9	60.6	64.7
Range	47.3 to 62.5	49.7 to 60.3	58.9 to 64.4	54.3 to 67.1	59.6 to 68.2
Standard Deviation	6.5	7.5	2.8	4.7	4.5

N. SPECIFIC GRAVITY @ 77°F

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	1.019	1.016	1.017	1.030	1.022
Range	1.004 to 1.028	1.015 to 1.017	1.004 to 1.025	1.027 to 1.033	1.017 to 1.027
Standard Deviation	0.011	0.001	0.012	0.002	0.005

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	7	3
Mean	1.017	1.016	1.018	1.031	1.022
Range	0.999 to 1.026	1.015 to 1.016	1.006 to 1.026	1.026 to 1.036	1.017 to 1.027
Standard Deviation	0.012	0.001	0.011	0.003	0.005

O. FLASH POINT, CLEVLAND OPEN CUP, °F

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	533	570	603	548	582
Range	470 to 635	545 to 595	590 to 620	470 to 625	555 to 630
Standard Deviation	76.0	35.4	15.3	52.7	41.9

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	7	3
Mean	543	571	618	-	-
Range	450 to 630	545 to 597	610 to 630	495 to 600+	310+ to 560
Standard Deviation	84.1	36.8	10.4	-	-

P. DUCTILITY @ 39.2°F, 1 cm/min., ORIGINAL SAMPLE (CENTIMETERS)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	150.0+	150.0+	28.25	42.6	42.25
Range	-	-	6.25 to 39.75	11.25 to 140.75	15.0 to 73.75
Standard Deviation	-	-	19.1	45.7	29.6

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	1	2	2	1	3
Mean	-	-	-	-	23.3
Range	-	15.0+ to 75.0+	-	-	4.0 to 40.0
Standard Deviation	-	-	-	-	18.1

Q. DUCTILITY @ 77°F, 5 cm/min., ORIGINAL SAMPLE (CENTIMETERS)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	98.25	110.1	150.0+	148.5	150.0+
Range	89.25 to 114.25	95.0 to 125.25	-	138.0 to 150.0+	-
Standard Deviation	11.1	21.4	-	4.2	-

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	1	2	3	3
Mean	-	-	-	150.0+	-
Range	130.0+ to 150.0+	-	130.0+ to 150.0+	-	140.0+ to 150.0+
Standard Deviation	-	-	-	-	-

R. SOLUBILITY IN TRICHLOROETHYLENE, (%)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	99.72	99.98	99.75	99.98	99.94
Range	98.93 to 99.99	99.97 to 99.98	99.28 to 99.98	99.97 to 99.99	99.91 to 99.96
Standard Deviation	0.52	0.01	0.40	0.01	0.03

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	2	7	3
Mean	99.96	99.93	99.94	99.93	99.78
Range	99.92 to 99.98	99.89 to 99.96	99.90 to 99.98	99.70 to 99.99	99.70 to 99.95
Standard Deviation	0.03	0.05	0.06	0.10	0.14

S. SOFTENING POINT, ETHYLENE GLYCOL, (°F)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	110	106	118	122	118
Range	107 to 113	105 to 107	115 to 121	120 to 125	117 to 119
Standard Deviation	2.5	1.4	3.0	1.7	1.0

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	1	2	2	2
Mean	111	-	122	124	117
Range	104 to 115	-	121 to 123	122 to 125	116 to 118
Standard Deviation	6.1	-	1.4	2.1	1.4

T. Penetration Viscosity Number, (PVN)

The penetration viscosity number, PVN, is an indicator of the temperature susceptibility of asphalt cements. Lower PVN indicates greater temperature susceptibility. It is suggested that an asphalt cement with a PVN less than -0.5 is temperature susceptible.

$$PVN = \frac{\text{Log A} - \text{Log V}}{\text{Log A} - \text{Log B}} \times (-1.5)$$

Where Log A = 4.25800 - 0.79674 Log (Penetration @ 77°F)
Log B = 3.46289 - 0.61094 Log (Penetration @ 77°F)
Log V = Log (Viscosity @ 275°F, Kinematic)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	-0.443	-0.583	-0.721	-0.343	-0.622
Range	+0.078 to -1.227	-0.532 to -0.634	-0.641 to -0.858	-0.003 to -0.658	-0.397 to -0.0771
Standard Deviation	0.578	0.072	0.119	0.235	0.198

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	7	3
Mean	-0.491	-0.637	-0.686	-0.361	-0.608
Range	-0.030 to -1.279	-0.564 to -0.710	-0.603 to -0.827	-0.013 to 0.595	-0.420 to -0.732
Standard Deviation	0.562	0.103	0.123	0.224	0.165

U. PENETRATION INDEX NUMBERS, (PIN)

The Penetration Index Number is another indicator of temperature susceptibility of asphalt cements. Large negative values of PIN indicate greater temperature susceptibility. "Typical" asphalts have values between +2 and -2.

$$PIN = \frac{30}{1 + 90\ PTS} - 10$$

PTS = Penetration Temperature Susceptibility

$$PTS = \frac{\text{Log } 800 - \text{Log (Penetration @ } 77°F)}{\text{Softening Point } (°F) - 77°F}$$

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	+0.418	-0.236	-0.692	-0.064	-0.359
Range	+0.164 to +0.946	+0.016 to -0.488	-0.472 to -0.893	+0.235 to -0.334	-0.143 to -0.497
Standard Deviation	0.356	0.356	0.211	0.175	0.190

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	1	2	2	2
Mean	+0.739	-	-0.033	+0.357	-0.400
Range	+1.911 to -0.991	-	+0.201 to -0.267	+0.934 to -0.221	-0.336 to -0.464
Standard Deviation	1.529	-	0.331	0.817	0.091

V. A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES

by

H. Plancher)
J. C. Petersen) Laramie Energy Technology Center
U.S. Department of Energy
P.O. Box 3395
Laramie, Wyoming 82071

A. J. Hoiberg)
S. C. Suhaka) Johns - Manville Sales Corporation
R&D Center
Ken - Caryl Ranch
Denver, Colorado 80217

The asphaltene settling test is used to evaluate the relative degree of dispersion of asphaltenes from paving asphalts. This test distinguishes differences in asphaltene settling times of asphalts in their hexane-maltene solutions. The test involves digesting asphalt in n-hexane, transferring the contents into a graduated cylinder and measuring the time required for the asphaltene meniscus to settle to the 25 ml. mark of a 50 ml. cylinder. Slower settling times indicate a greater degree of dispersion of the asphaltenes and thus a more compatible asphalt, which in turn is considered to be an important property that contributes to asphalt durability. The test is extremely sensitive to changes in asphalt composition. Time is reported in minutes.

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	29.6	37.0	41.9	24.7	65.3
Range	18.5 to 46.6	31.1 to 42.8	25.8 to 63.7	17.3 to 34.5	21.3 to 130.0
Standard Deviation	13.3	8.3	19.6	7.1	57.2

W. SEPARATION OF ASPHALT INTO FOUR FRACTIONS MODIFIED METHOD OF ASTM D 4124-82
SECTION 4, VOLUME 04.03

The purpose is to separate the four generic fractions present in asphalt. These fractions are saturates, naphthene aromatics, polar aromatics, and asphaltenes. The relative amount of each fraction plays a role in determining the physical properties of the asphalt. These properties include viscosity, ductility, softening point and temperature susceptibility.

The procedure follows:

The percent asphaltene is determined by dispersing the asphalt in n-heptane and refluxing. The insolubles are the asphaltenes.

The remaining three fractions are determined by absorbing the deasphaltened n-heptane solution on a calcined alumina chromatography column and eluting (removing) each fraction with a different solvent. Saturates are eluted with n-heptane. Naphthene aromatics are eluted with toluene. Polar Aromatics are eluted with 50/50 toluene - methanol solution, followed by trichloroethylene. The solvents are then evaporated and weight percentages of each fraction with respect to the original asphalt sample are determined.

ASPHALTENES, %

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	13.5	12.7	9.9	16.7	14.2
Range	7.6 to 18.0	11.6 to 13.8	6.9 to 12.2	12.9 to 19.2	13.3 to 15.4
Standard Deviation	5.1	1.6	2.7	2.2	1.1

SATURATES, %

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	12.1	16.5	10.0	9.4	11.3
Range	9.7 to 13.4	13.6 to 19.4	9.6 to 10.3	5.5 to 16.6	9.7 to 12.2
Standard Deviation	1.7	4.1	0.4	3.5	1.4

NAPHTHENE - AROMATICS, %

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	28.5	25.8	31.0	24.9	30.0
Range	24.5 to 34.7	22.8 to 28.8	27.1 to 37.0	20.1 to 29.5	28.1 to 33.3
Standard Deviation	4.6	4.2	5.3	2.7	2.8

POLAR AROMATICS, %

1. Materials Bureau

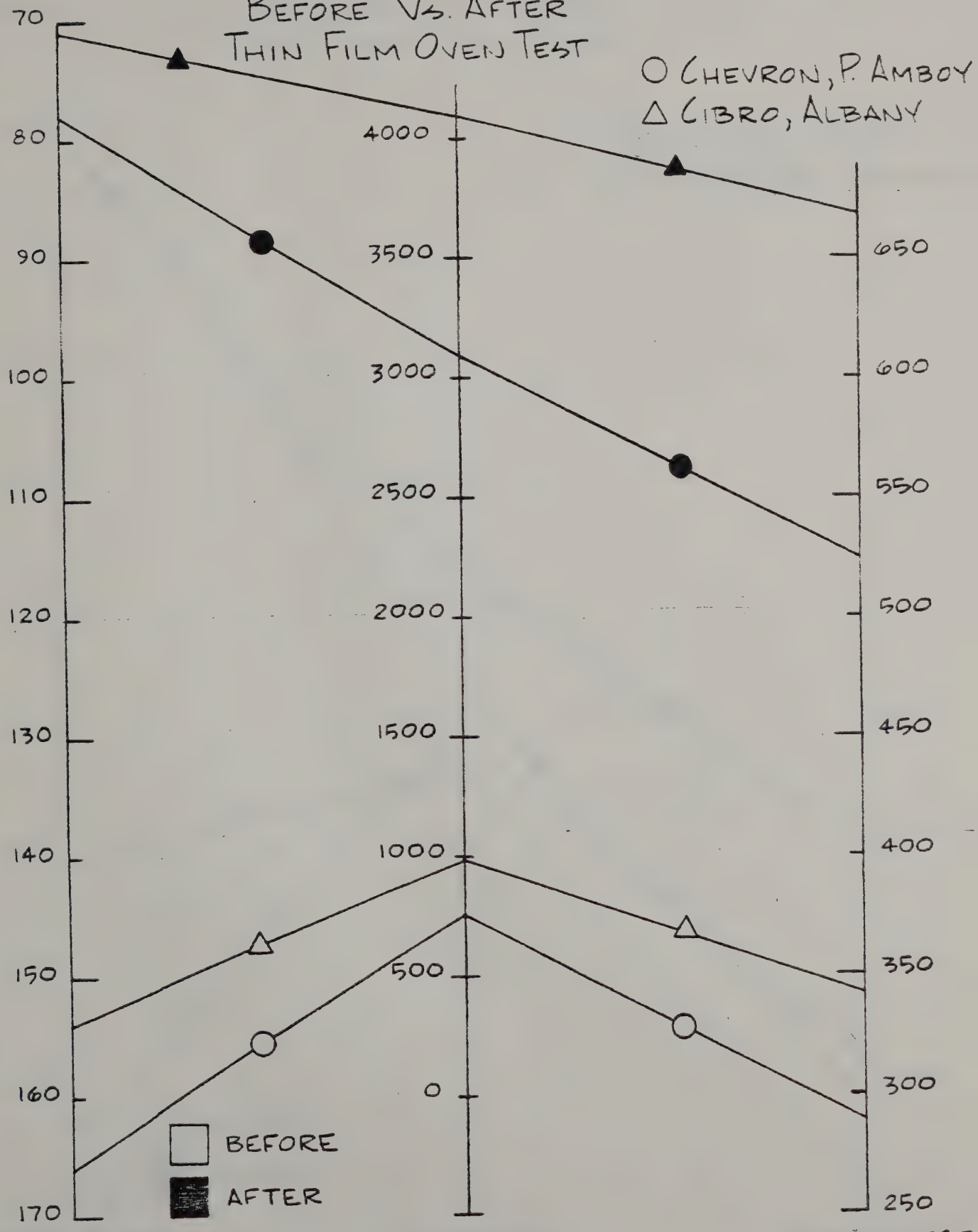
	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	4	2	3	8	3
Mean	40.5	39.3	41.9	42.1	39.2
Range	37.3 to 43.4	36.6 to 42.0	39.1 to 43.9	39.1 to 44.4	37.6 to 41.6
Standard Deviation	2.7	3.8	2.5	2.1	2.1

IX. GRAPHS AND CHARTS OF RELATED MATERIAL INFORMATION

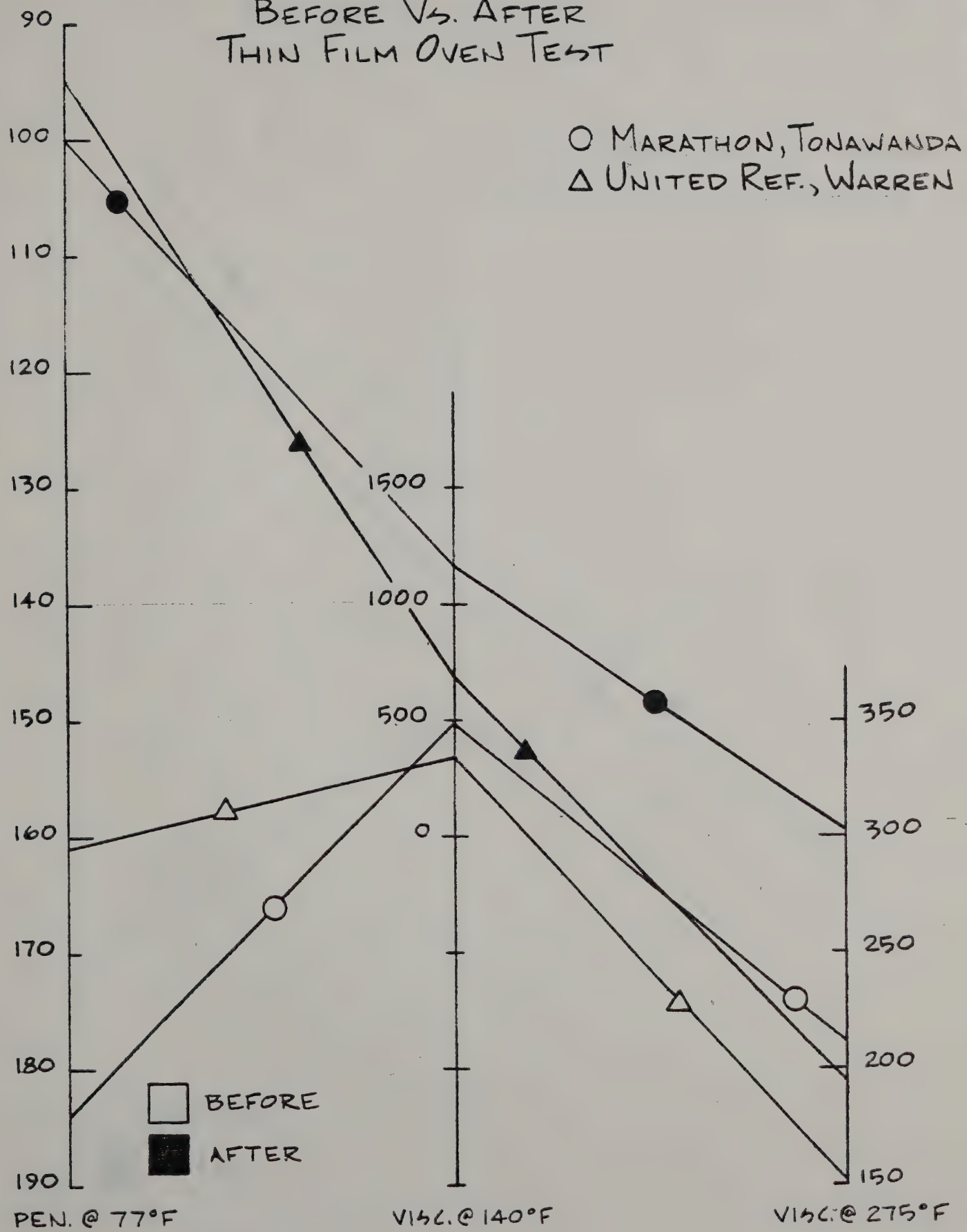
On the following pages are found a series of graphs and charts providing a comparison of thin film oven test, before and after, and charts showing asphaltene dispersion settling test.

COMPARISON FLUX, BEFORE VS. AFTER THIN FILM OVEN TEST

○ CHEVRON, P. AMBOY
△ CIBRO, ALBANY

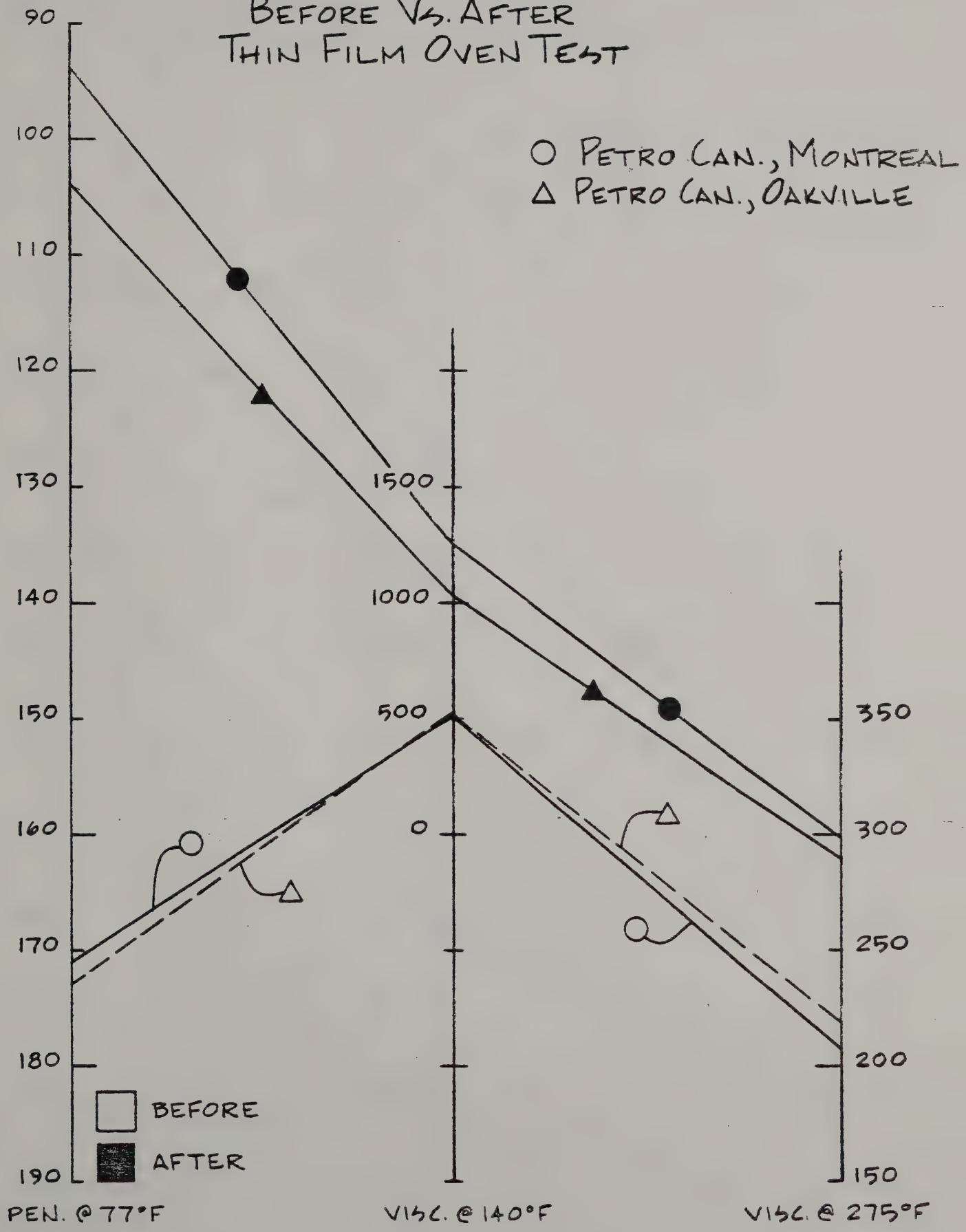


COMPARISON FLUX, BEFORE VS. AFTER THIN FILM OVEN TEST



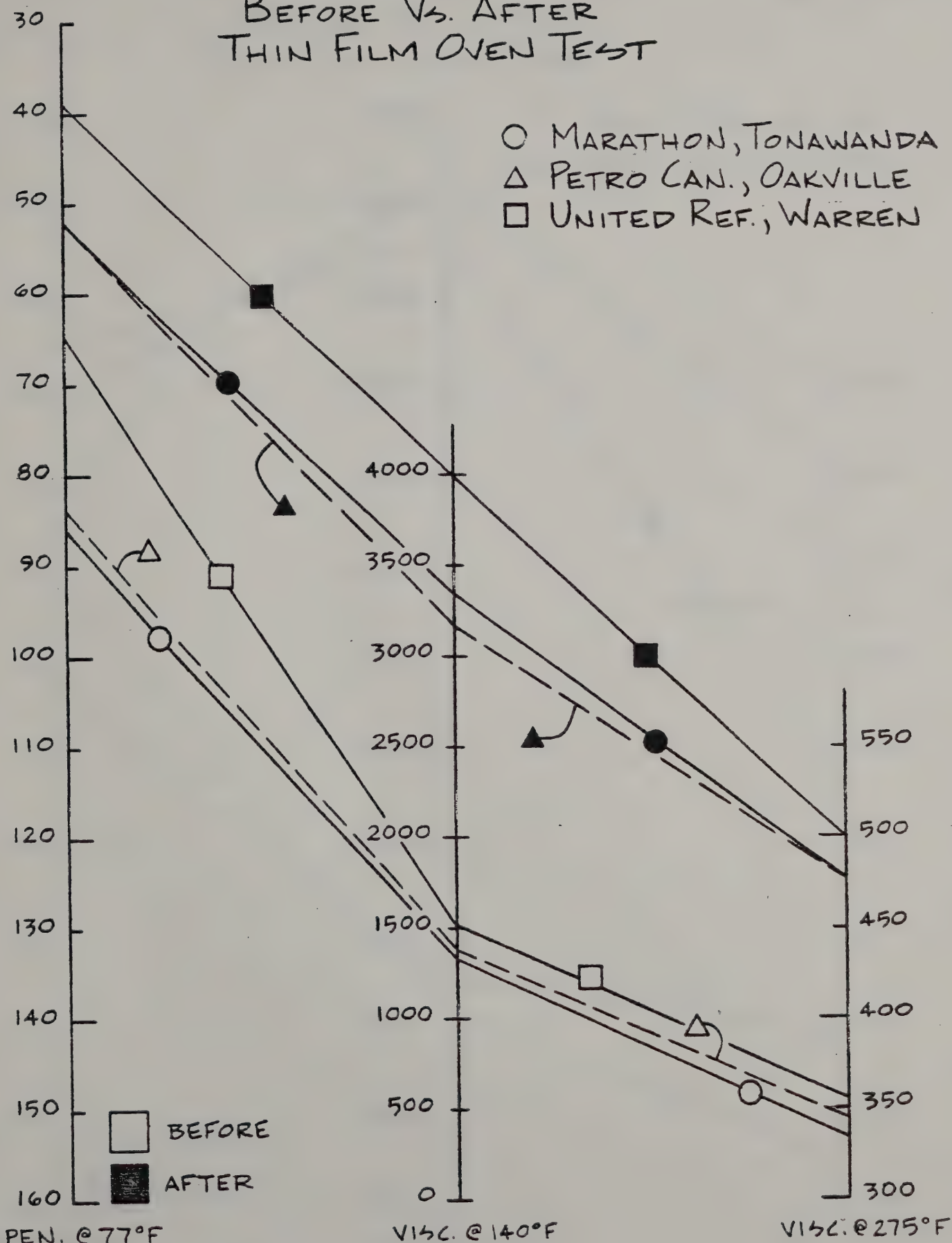
COMPARISON AC-5
BEFORE VS. AFTER
THIN FILM OVEN TEST

S.J.P.

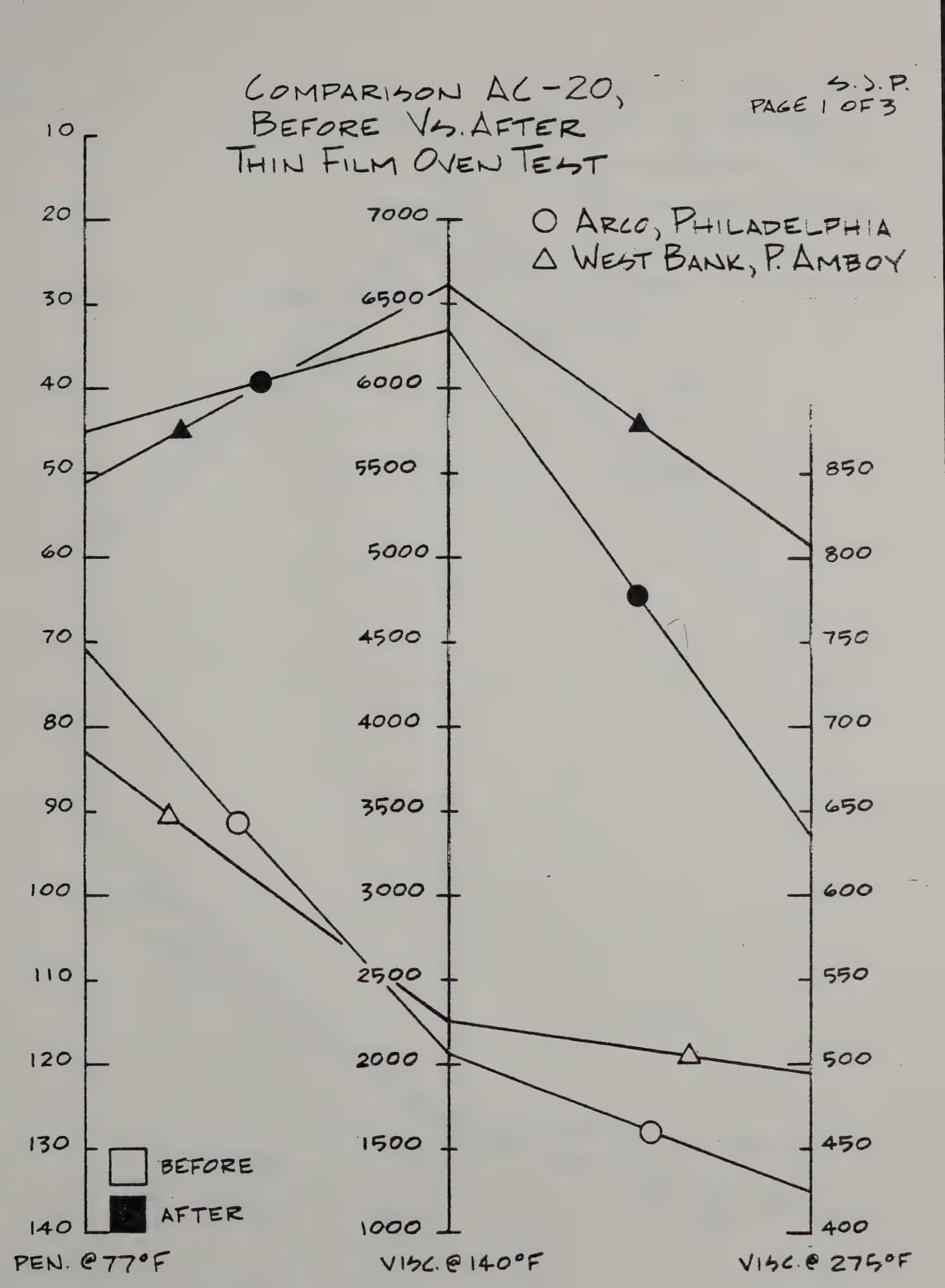


S.J.P

Comparison AC-15, Before Vs. After Thin Film Oven Test



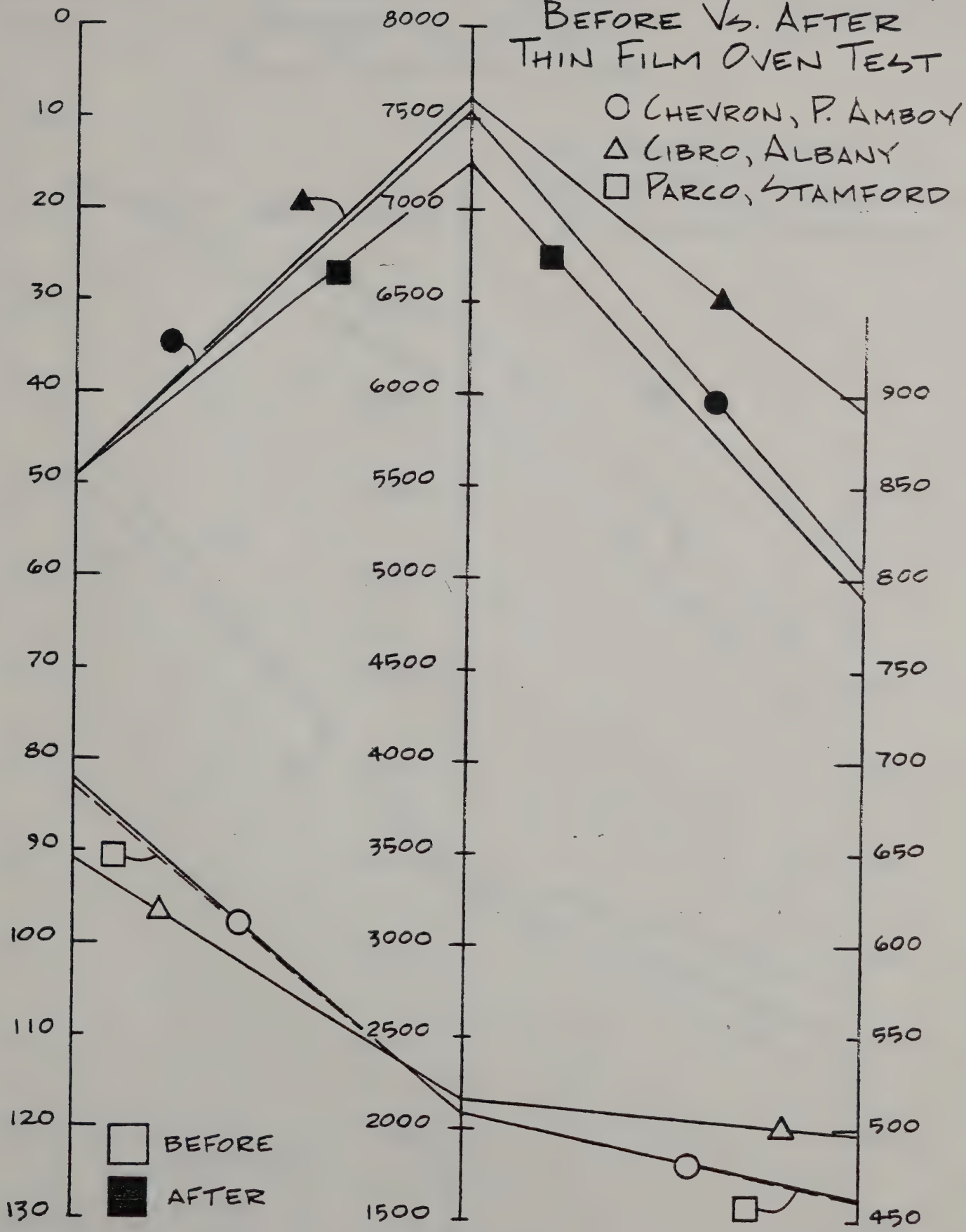
COMPARISON AC-20, BEFORE VS. AFTER THIN FILM OVEN TEST



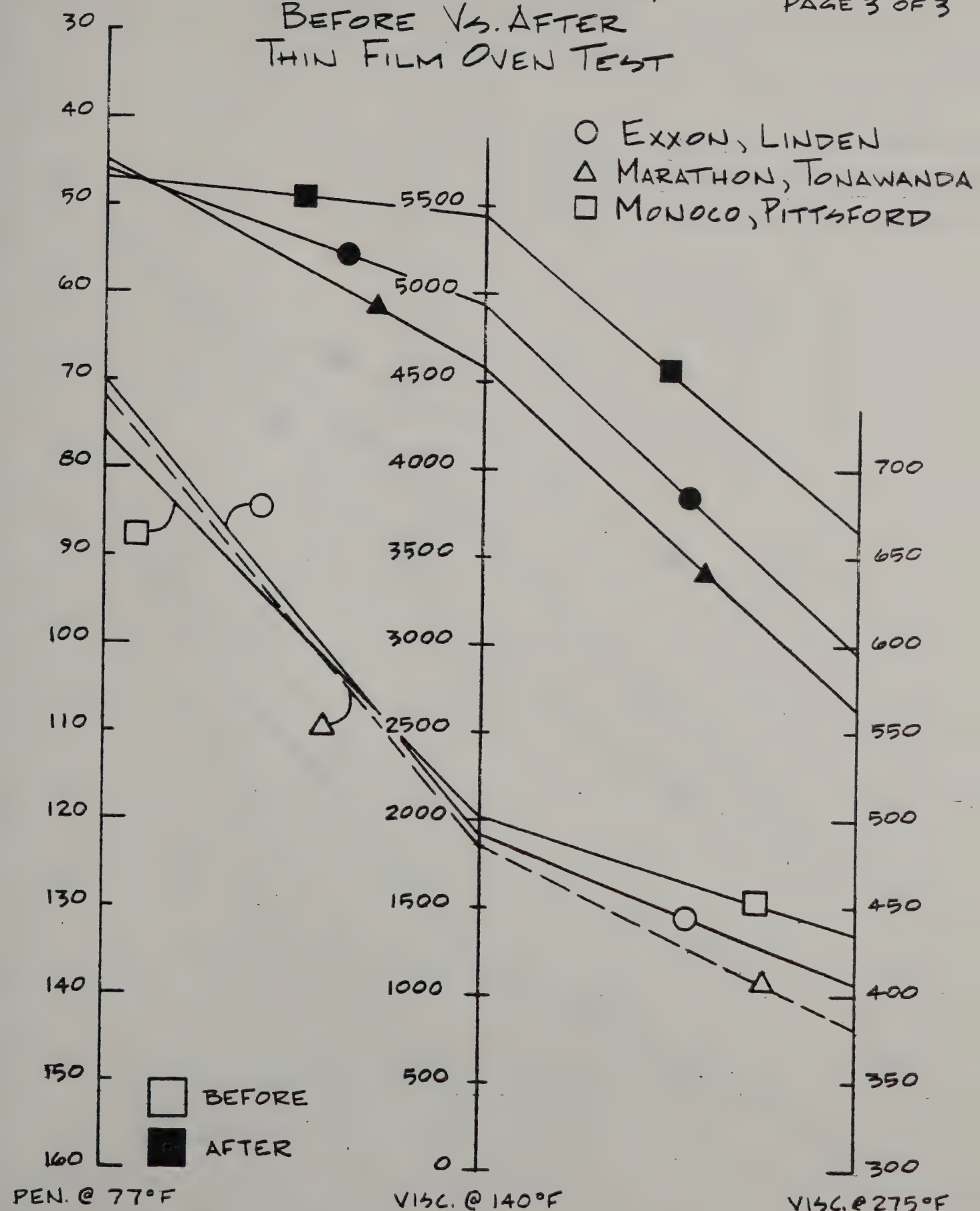
S. J. P.
PAGE 2 OF 3

COMPARISON AC-20, BEFORE VS. AFTER THIN FILM OVEN TEST

○ CHEVRON, P. AMBOY
△ CIBRO, ALBANY
□ PARCO, STAMFORD

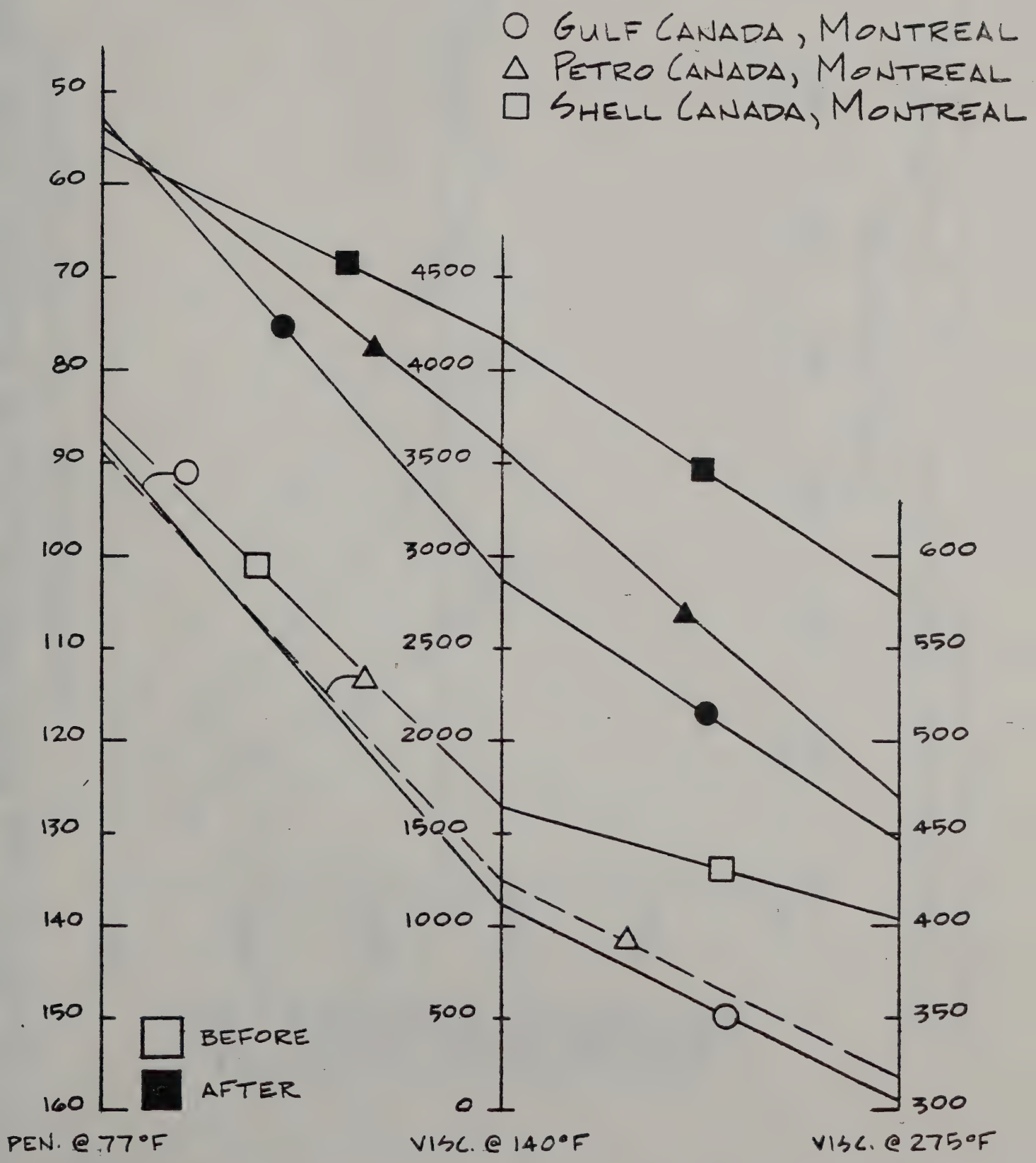


COMPARISON AC-20, BEFORE VS. AFTER THIN FILM OVEN TEST

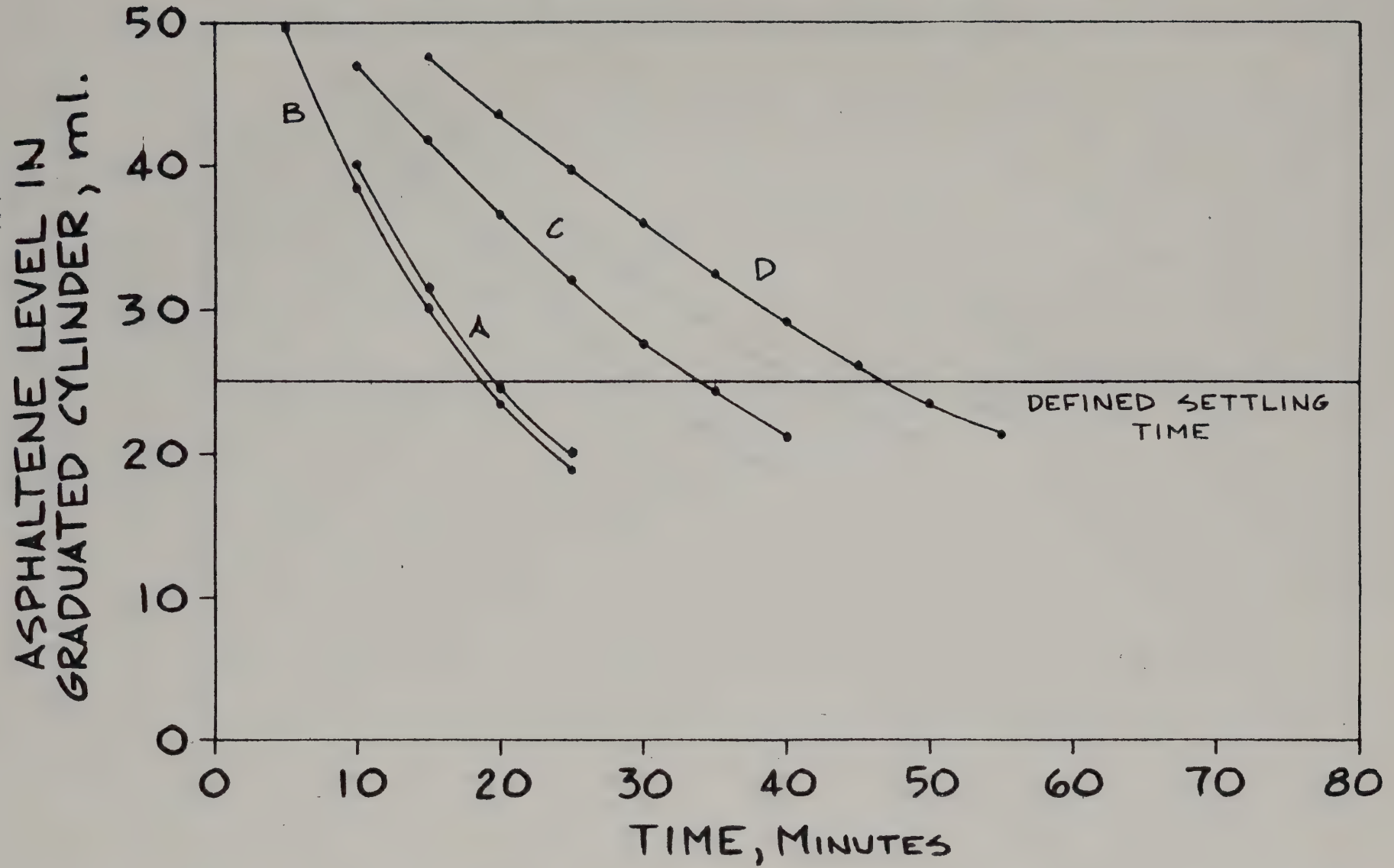


Comparison 85/100, Before Vs. After Thin Film Oven Test

S.J.P.



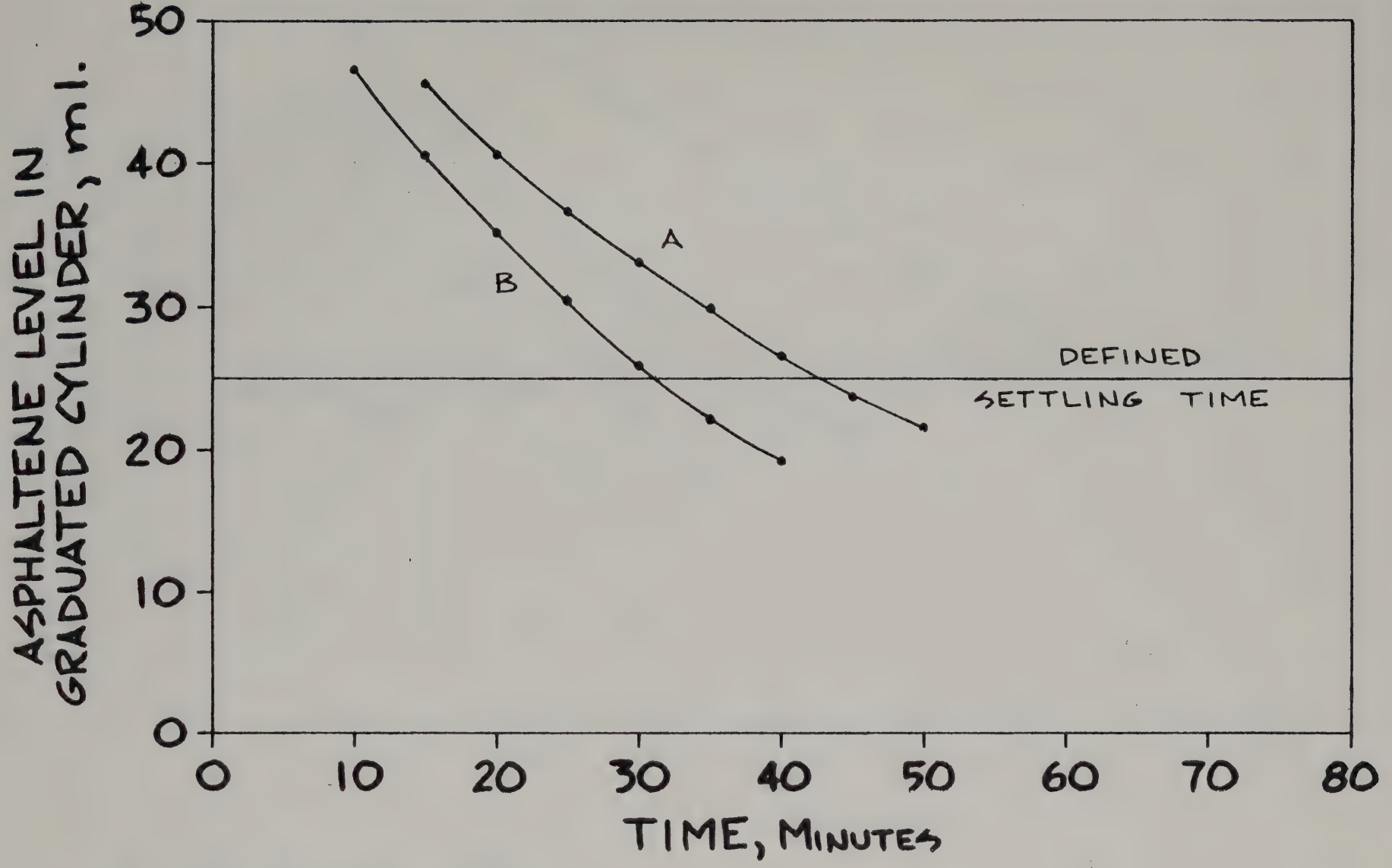
A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES



A = FLUX, CHEVRON, PERTH AMBOY
B = FLUX, CIBRO, ALBANY
C = FLUX, MARATHON, TONAWANDA
D = FLUX, UNITED REF., WARREN

S.J.P.

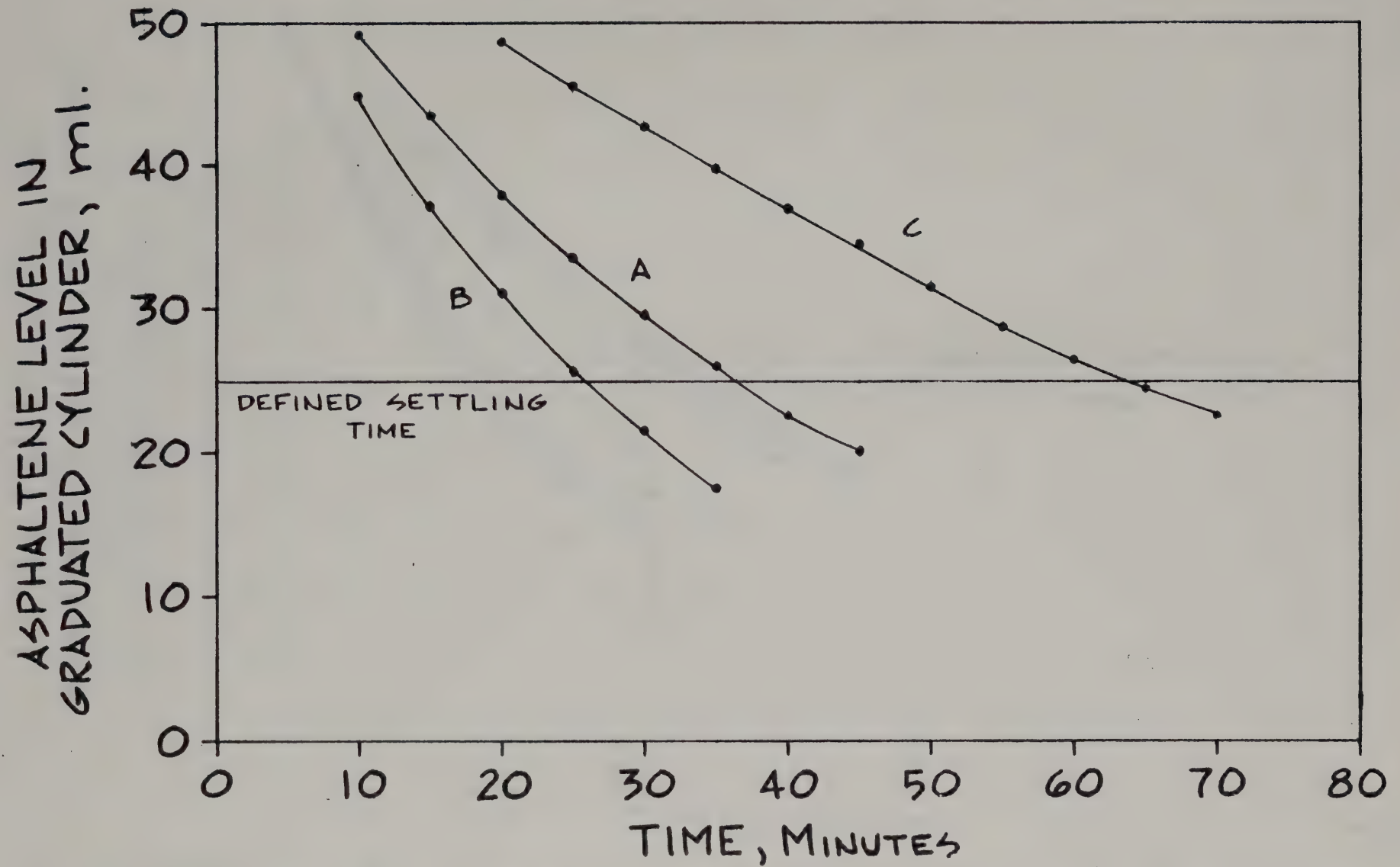
A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES



A = AC-5, PETRO-CANADA, MONTREAL
B = AC-5, PETRO-CANADA, OAKVILLE

S.J.P.

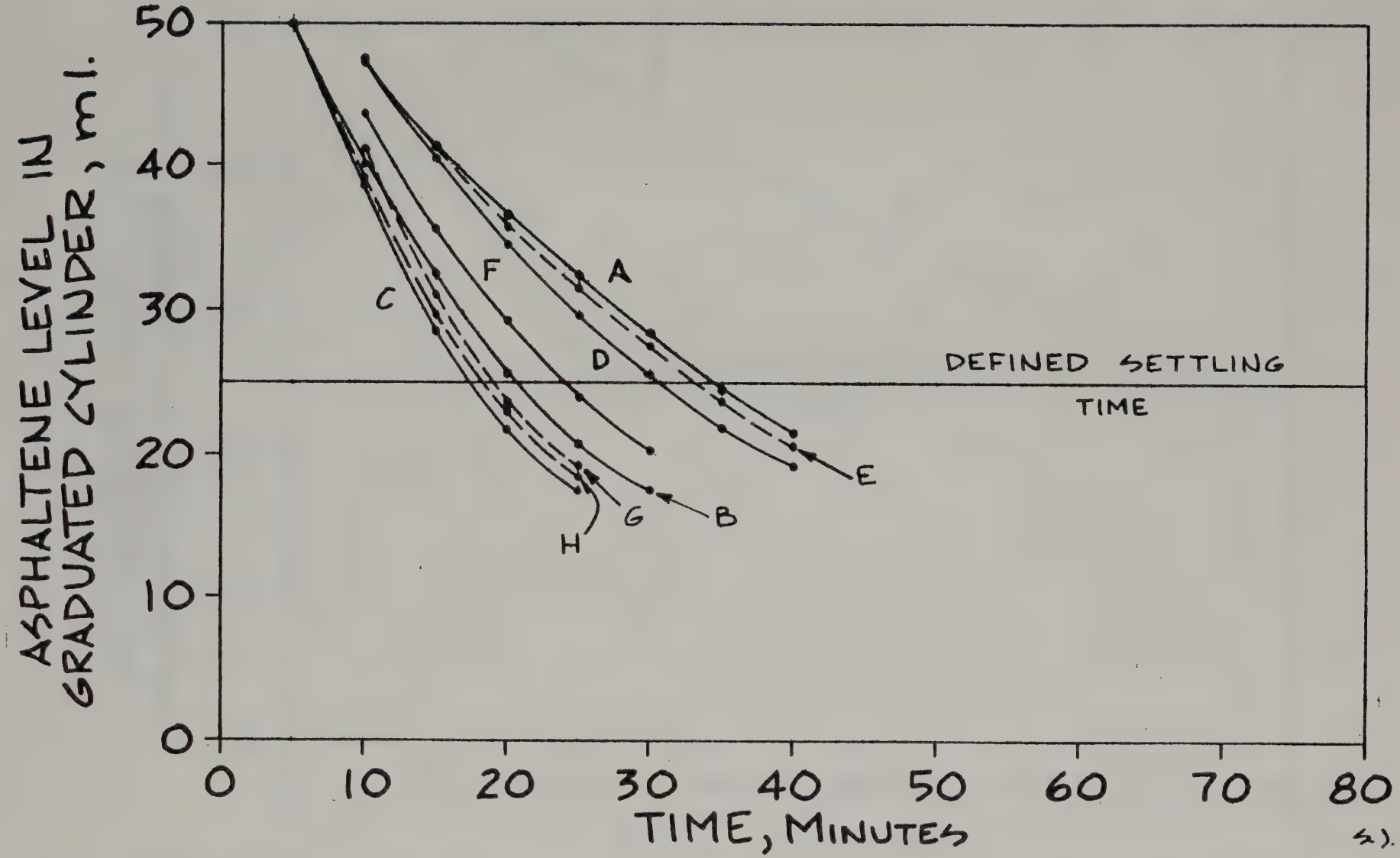
A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES



A = AC-15, MARATHON, TONAWANDA
B = AC-15, PETRO-CANADA, OAKVILLE
C = AC-15, UNITED REF., WARREN, PA.

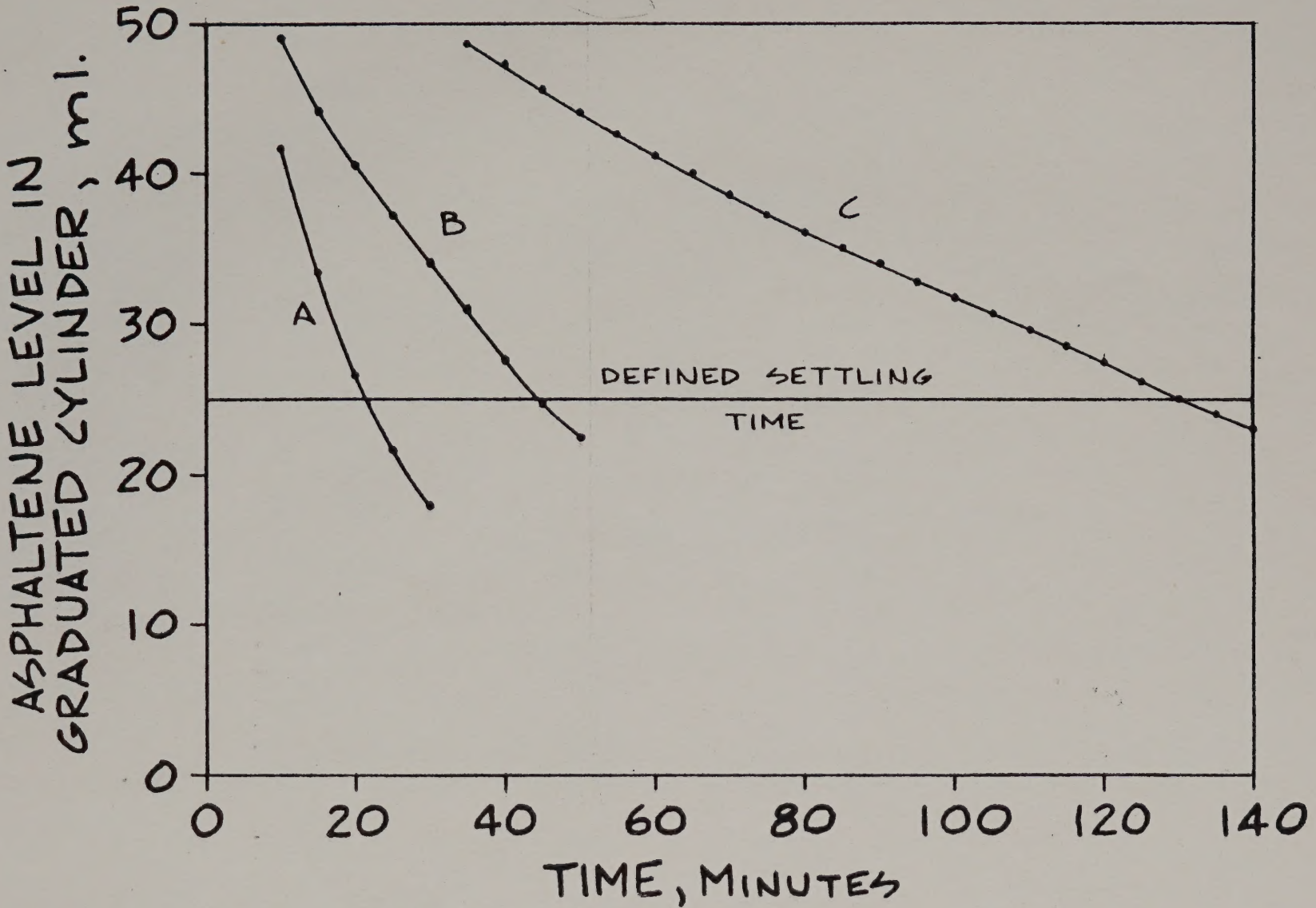
S.J.P.

A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES



A = AC-20, ARCO, PHILADELPHIA
B = AC-20, CHEVRON, PERTH AMBOY
C = AC-20, CIBRO, ALBANY
D = AC-20, EXXON, LINDEN
E = AC-20, MARATHON, TONAWANDA
F = AC-20, MONOCO, PITTSFORD
G = AC-20, PARCO, STAMFORD
H = AC-20, WEST BANK, P. AMBOY

A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES



A = 85/100, GULF CANADA, MONTREAL
B = 85/100, PETRO CANADA, MONTREAL
C = 85/100, SHELL CANADA, MONTREAL

S.J.P.

0
20
40
60
80
100
120
140
TIME
A
B
C

01545
LRI